EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 57205336
PUBLICATION DATE : 16-12-82

APPLICATION DATE : 10-06-81
APPLICATION NUMBER : 56089122

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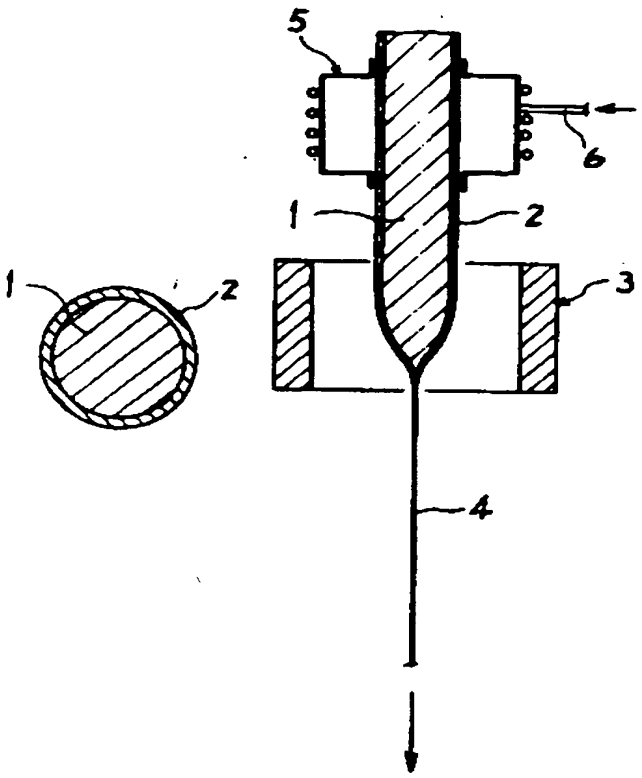
INT.CL. : C03B 37/025 C03C 25/02 // G02B 5/14

TITLE : MANUFACTURE OF METAL COATED OPTICAL FIBER



ABSTRACT : PURPOSE: To obtain an optical fiber having a uniform metallic coat without deteriorating the original transmitting characteristics by spinning a preform rod after forming a metallic coat with a higher b.p. than the spinning temp. around the rod.

CONSTITUTION: A metallic coat 2 of a metallic material with a higher b.p. than the spinning temp. such as Al or Cr is formed around a preform rod 1 of quartz or the like by a known means such as vapor deposition or chemical plating. The rod 1 having the coat 2 is heated with a heating furnace 3 and spun by a drawing means (not shown) to obtain a metal coated optical fiber 4 having the desired fiber diameter. The spinning temp. is regulated to a temp. below the b.p. of the metallic material of the coat 2, usually to 1,800~2,200°C. When the coat 2 is preheated prior to spinning, it is heated to a temp. close to the m.p. with a heater 5 set before the furnace 3.

⑲ 日本国特許庁 (JP)　　⑪ 特許出願公開

⑫ 公開特許公報 (A)　　昭57—205336

⑤Int. Cl.³	識別記号	庁内整理番号
C 03 B 37/025		6602—4G
C 03 C 25/02		8017—4G
// G 02 B 5/14		7529—2H

⑬公開　昭和57年(1982)12月16日

発明の数　1

審査請求　未請求

(全 3 頁)

⑭金属被覆光ファイバの製造方法

⑳特　　願　昭56—89122

㉒出　　願　昭56(1981)6月10日

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明　細　書

1. 発明の名称　金属被覆光ファイバの製造方法

2. 特許請求の範囲

(1) プリフォームロッドの外周に溶点が紡糸温度以上の金属被覆層を形成した後、プリフォームロッドを紡糸することを特徴とした金属被覆光ファイバの製造方法。

(2) 金属被覆層を同層の融点付近に予備加熱しておく特許請求の範囲第1項記載の金属被覆光ファイバの製造方法。

(3) 予備加熱は酸素雰囲気中で行なう特許請求の範囲第2項記載の金属被覆光ファイバの製造方法。

3. 発明の詳細な説明

本発明は金属被覆光ファイバの製造方法に関するものである。

光ファイバの被覆として金属被覆層を形成する場合、プラスチック被覆層に比べて機械的強度、耐熱耐火性が高い他、耐水防湿性などの点でも有力視されている。

従来において上記の金属被覆光ファイバを製造するとき、紡糸工程(加熱延伸工程)で製造された後の光ファイバ外周に気相の手段で金属被覆層を形成していたが、この方法によるときでは、石英等からなる光ファイバと金属被覆層との界面における密着状態の不均一などが起りがちであり、これにより金属被覆後の伝送特性が低下していた。

ちなみに、光ファイバをアルミニウムまたはチタンで金属被覆した場合(被覆厚10～20 μm)、1 dB/km以上の損失増加が生じたとの文献報告もあり、これの改善が希求されている。

本発明は上記の観点に鑑みこの種金属被覆光ファイバの製造方法を改良したもので、以下

属被覆層(2)を形成する。

上記における金属被覆層(2)としては、後述する紡糸温度よりも融点の高い金属材料が採用され、これの具体的なものとしては、アルミニウム（２３７９０）、クロム（２２００℃）、チタン（３９０００以上）、ニクケル（３０００℃以上）などがあげられる（カッコ内は融点を示す）。

この際の金属被覆層(2)は既知の金属蒸着手段、化学メッキ手段等を介してプリフォームロッド(1)の外周に形成できるが、同層(2)の形成に際しては、ガラスとの密着性、すなわちプリフォームロッド(1)は、第２図のごとく紡糸炉(3)を介した加熱と図示しない延伸手段とにより紡糸されて所望線径の金属被覆光ファイバ(4)となる。

ここでの紡糸温度は通常１８００～２２００℃の範囲内で設定され、同温度は前記金属の融点を下回ることになる。

また、この際の紡糸加工に際しては、上記金属被覆層(2)を前もつて予備加熱する場合と加熱しない場合とがあり、加熱する場合では紡糸炉(1)の直後にある加熱器(5)を介して同層(2)をその融点付近まで加熱するとともに、さらに酸素供給系(6)を介して加熱器(5)内を酸素雰囲気に保持したりする。

上記予備加熱により金属被覆層(2)を高温状態にした場合、同層(2)とプリフォームロッド(1)との密着性がより良好となり、また、この加熱を上記のごとき酸素雰囲気中で実施した場合には、当該金属被覆層(2)の表面に高融点の酸化被膜が形成されることとなり、したがつて紡糸後における金属被覆層(2)の損傷状況がよくなり、２重の金属被覆をしたと同様の効果が得られることになる。

この際紡糸温度は金属の融点よりも高く、かつ酸化金属の融点と同程度以下に設定することが好ましい。

なお、紡糸炉(3)としてジルコニア炉のごとく酸素雰囲気中での予備加熱がこの炉(3)により同時に行なえる。

このようにして金属被覆光ファイバ(5)を製造する場合、つぎのような利点が得られることになる。

つまり上記では、光ファイバの段階で金属被覆するのでなく、プリフォームロッド(1)の段階で金属被覆し、その後これを紡糸している。

したがつて金属被覆層(2)はプリフォームロッド(1)に被着した後、紡糸時において該ロッド(1)と共に加熱溶融されるから、両者の界面における密着状態が均一で強力となり、この結果、金属被覆したがために伝送損失が増加するといつたことはなくなり、所定の伝送特性が保持できることとなる。

もちろん上記の金属被覆層(2)は紡糸温度よりも高い融点を有しているので紡糸時に金属揮散が起こるといつたこともなく、機械的強度、耐熱耐火性、耐水防腐性も問題なく確保できる。

また、巨大なプリフォームロッド(1)の段階で金属被覆する場合、個別の光ファイバに金属被覆になると共に金属被覆時の厳度も緩和されることとなり、さらに金属被覆に多少の偏肉が生じたとしてもプリフォームロッド(1)の径が大きいため偏肉率は大きな値にならず、したがつてこのような観点からも金属被覆の均一化が実現しやすくなる。

実施例

コア部が$SiO_2-GeO_2-P_2O_5$系、クラッド部がSiO_2からなる外径１５mmのプリフォームロッド(1)を用意し、これの外周にＣｒからなる金属被覆層(2)を真空蒸着により形成した後、該金属被覆層(2)を空気中において酸水素バーナにより一たん加熱処理した。

ついで上記のごとく金属被覆されたプリフォームロッド(1)を約１９８００のカーボン抵抗炉（紡糸炉(4)）で紡糸し、コア径５０μm、ファイバ径１２５μm、紡糸後における金属被覆層(2)の厚さ１mμm、比屈折率差１％のＧＩ型金属被覆光ファイバ(4)を得た。

送特性を波長0.85μmにより測定したところ、その伝送損失は2.35dB/kmでもつた。

比較のため、上記と同一仕様のプリフォームロッドを金属被覆しない状態で紡糸してコア径90μm、ファイバ径125μmの光ファイバをつくり、これの伝送損失を測定したところ、2.32dB/kmであつた。

両例を対比して明らかなように、本発明の実施例では金属被覆したにもかかわらず、これのないものに比べた伝送損失増は微増にとどまつており、本発明の有効性が確認できた。

また、紡糸後における金属被覆層(2)の厚さが1mm以下であつても、耐水防湿性の点に問題がないことが確認できた。

以上説明した通り、本発明方法が特徴としている技術手段によれば、プリフォームロッドの段階で所定の金属被覆層を形成し、これを紡糸するようにしているから、本来の伝送特性を低下させることのない、しかも均一な金属被覆層をもつ金属被覆光ファイバが製造できることとなる。

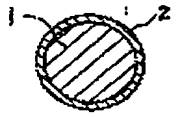
4. 図面の簡単な説明

図面は本発明の1実施例を示したもので、第1図はプリフォームロッドの金属被覆状態を示した断面図、第2図は該ロッドの紡糸状態を示した説明図である。

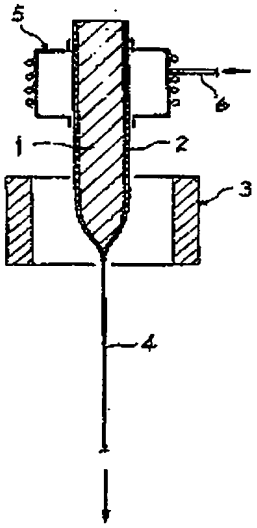
(1)・・・・・プリフォームロッド
(2)・・・・・金属被覆層
(3)・・・・・紡糸炉
(4)・・・・・金属被覆光ファイバ
(5)・・・・・加熱器
(6)・・・・・酸素供給系

特許出願人
代理人 弁理士 斎藤 義雄

第1図



第2図



(19) Japanese Patent Office (JP)

(12) PATENT DISCLOSURE BULLETIN (A)

(11) Patent Application Disclosure No.: Patent Disclosure

57-205336 (1982)

(43) Disclosure Date: December 16, 1982

(51) Int.Cl[3] Identification Symbol

C03B 37/025

C03C 25/02

G02B 5/14

Patent Office Assigned Number

6602-4G

8017-4G

7529-2H

Search Request: Not yet made

Number of Invention: 1 (Total page: 3)

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(54) Subject of Invention Manufacturing Method of Metal-Coated Optical Fiber

(21) Application Number : Patent Application 56-89122 (1981)

(22) Application Date: June 10, 1981

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DETAILED DESCRIPTION

1. Subject Of Invention

Manufacturing method of metal-coated optical fiber

2. Scope of the Patent Claim

(1) A manufacturing method of metal-coated optical fiber having the following characteristics: after forming a metal coating layer whose boiling point is more than the fiber spinning (drawing) temperature onto the outer circumference of a preform rod, the preform rod is spun (drawn) into fiber.

(2) In the manufacturing method of metal-coated optical fiber described in Claim Item (1), Scope of the Patent Claim, the metal coating layer is preheated to the vicinity of the melting temperature of the metal coating layer.

(3) In the manufacturing method of metal-coated optical fiber described in Claim Item (2), Scope of the Patent Claim, the preheating is performed in an oxygen atmosphere.

3. Detailed Explanation of the Invention

The present invention is related to a manufacturing method of metal-coated optical fiber.

The forming of metal protective layer as a coating of optical fiber has already been proposed. In the case of a metal coating layer, it has been regarded to be better in mechanical strength compared to a plastic coating layer, as well as higher in heat resistance refractory property and water resistance humidity prevention property, etc.

Hitherto, in the manufacturing of the aforementioned metal coated optical fiber, after the optical fibber is manufactured by a spinning (drawing) process (heat elongation process), a metal coating layer is formed onto the outer circumference of the optical fiber by an established method. However, in this approach, non-uniform adhesion and other (defects) tend to occur at the interface between the optical fiber composed of quartz, etc. and the metal coating layer. By this, the transmission performance after the metal coating would be lowered.

In this regard, in the case where the optical fiber is coated with metal such as aluminum or titanium (coating thickness 10 to 20 um), there are references that more than 1 dB/km loss increases have occurred. Therefore, an improvement is being demanded.

The present invention is undertaken in view of the aforementioned problematic points to improve the __ (1character illegible) manufacturing method of metal coated optical fiber. A concrete method is illustrated below. As shown in Fig 1, to the outer circumference of the preform rod 1 composed of quartz system, the metal coating layer 2 is formed.

For the aforementioned metal coating layer 2, the metal materials (to be described later) possessing boiling points which are higher than the fiber spinning (drawing) temperature are employed. Concrete examples include aluminum (2270°C), chromium (2200°C), titanium (above 3000°C), Nickel (above 3000°C), etc. [The number in the parentis shows the boiling point.]

In this case, the metal coating layer 2 can be formed onto the outer circumference of the preform rod through the established metal vapor deposition method, the chemical plating method, etc. In the forming of the coating layer 2, the tight adhesion with the glass is important. Namely, the preform rod 1 is spun (drawn) into fiber as shown in Fig 2 by the heating in the spinning (drawing) furnace 3 and by an elongation (pulling) means (not shown in the figure) to become the metal coated fiber 4 of the desired fiber diameter.

Here, the spinning (drawing) temperature is set to be within the range of generally 1800 to 2200°C; this temperature is lower than the boiling points of the aforementioned metals.

And, in this spinning (drawing) process, the aforementioned metal coating layer 2 can be either preheated or without a preheating. In the case when it is preheated, the metal coating layer 2 is heated to the vicinity of the melting point of the metal through the heater 5 arranged at the front step of the spinning (drawing) furnace 1 (should be "3": a misprint). Further, through the oxygen supply system 6, the inside of the heater 5 is maintained in oxygen atmosphere.

By the aforementioned preheating, if the metal coating layer 2 is heated to high temperature condition, the tight adhesion between the metal coating layer 2 and the preform rod 1 would be improved; and in the case where this heating is carried out in the oxygen atmosphere as described above, an oxide coating film of high melting point would be formed on the surface of the metal coating layer 2. As a result, the surface condition of the metal coating layer 2 after the

spinning (fiber drawing) would become better. The effect similar to that achieved by two kinds of metal coating can be obtained.

In this, the spinning (fiber drawing) temperature is preferably set to be higher than the melting point of the metal and lower than the level of the melting point of the metal oxide.

Moreover, for the spinning (fiber drawing) furnace 3, if a zirconia furnace is employed, the preheating can be performed simultaneously in an oxygen atmosphere in this furnace 3.

In the case when the metal coated optical fiber 5 is manufactured as described above, the followings advantages would be obtained.

Namely, in the above description, the metal is not coated at the optical fiber step; instead the metal is coated at the step (stage) of preform rod 1; and it is then spun (drawn into fiber).

Therefore, during the spinning (fiber drawing) after the metal coating layer 2 has been coated-onto the preform rod 1, since the metal coating layer and the rod 1 are to be heated-melted together, the tight adhesion condition at the interface of the two would become uniform and strong. As a result, the so called increase in transmission loss by the metal coating would not occur; thus the desired transmission performance can be maintained.

Of course, since the aforementioned metal coating layer 2 possesses a boiling temperature which is higher than the spinning (fiber drawing) temperature, during the spinning, the metal would not be vaporized; thus it can be guaranteed that the problems associated to the mechanical strength, heat

resistance refractory property, water resistance humidity prevention property would not occur.

And, when the metal coating is performed at the step of preform 1 with large diameter, the breakage loss in the handling would be almost eliminated compared to the case where the metal coating is performed onto the extremely fine optical fiber. And also the temperature (best guess; poorly copied) during the metal coating can be moderated. Furthermore, even if the thickness deviation in the metal coating has occurred somewhat, due to the large diameter of the preform rod 1, the thickness deviation percentage would not become a large value; therefore, homogenization of the metal coating can be easier to achieve from these view points.

Implementation Example

The preform rod 1 of outside diameter 15 mm composed of core portion by SiO_2-GeO_2-P_2O_5 system and clad portion by SiO_2 was prepared. To the outer circumference of this rod, the metal coating layer 2 composed of Cr was formed by vacuum vapor deposition; then, the metal coating layer 2 was heat-treated once in air by an oxyhydrogen flame burner.

Next, the metal coated preform rod 1 coated with the metal as described above was spun (fiber drawn) in a carbon resistance furnace (the spinning furnace 4) of about 1980°C to obtain the GI type metal coated optical fiber 4 which is 50 μm in core diameter, 125 μm in fiber diameter, 1 mμm in the metal coating layer 2 thickness after the spinning, 1% in specific refractive index difference.

The transmission performance of the metal coated optical fiber 5 obtained as described above was measured by wavelength 0.85 μm: the transmission loss was 2.35 dB/km.

For comparison, an identical preform rod of the above described was spun (fiber drawn) without the metal coating to prepare an optical fiber of core diameter 50 um, fiber diameter 125 μm. The transmission loss of this fiber was measured; the result was 2.32 dB/km.

When the two examples are compared, even though in the implementation example of the present invention, a metal coating is applied, the increase in the transmission loss compared to the fiber without the metal coating was limited to a very small value: the effectiveness of the present invention was verified.

And it was verified that even if the thickness of the metal coating layer 2 after the fiber drawing is below 1 mμm, there is no problem related to the water resistance humidity prevention property.

As described above, by the technical means possessing the characteristics of the present invention method, since a specified metal coating layer is formed at the step (stage) of preform rod, and this is then spun (drawn) into fiber, the original transmission performance would not be lowered and yet a metal coated optical fiber possessing homogeneous metal coating layer can be manufactured.

4. Brief Explanation of Figures

The figures show an implementation example of the present invention. Fig 1 is the cross section showing the metal coated state of a preform rod. Fig 2 is an illustrating diagram showing the spinning (fiber drawn) state of the rod.

1...preform rod

2...metal coating layer

3...spinning (fiber drawing) furnace

4...metal coated optical fiber

5...heater

6...oxygen supplying system

Patent Applicant Agent, Attorney: __(not clearly copied). Saito

Fig 1

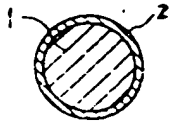

Fig 2